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Daniel et al.

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(54) **PRESS SHUTHEIGHT ADJUSTMENT USING BOLSTER HYDRAULIC TIE ROD ASSEMBLIES**

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(52) **U.S. Cl.** **100/347**; 100/99; 100/257; 72/21.1; 72/446
(58) **Field of Search** ..... 100/99, 214, 25, 100/7, 258 R, 347; 72/21.1, 446, 448, 455, 456

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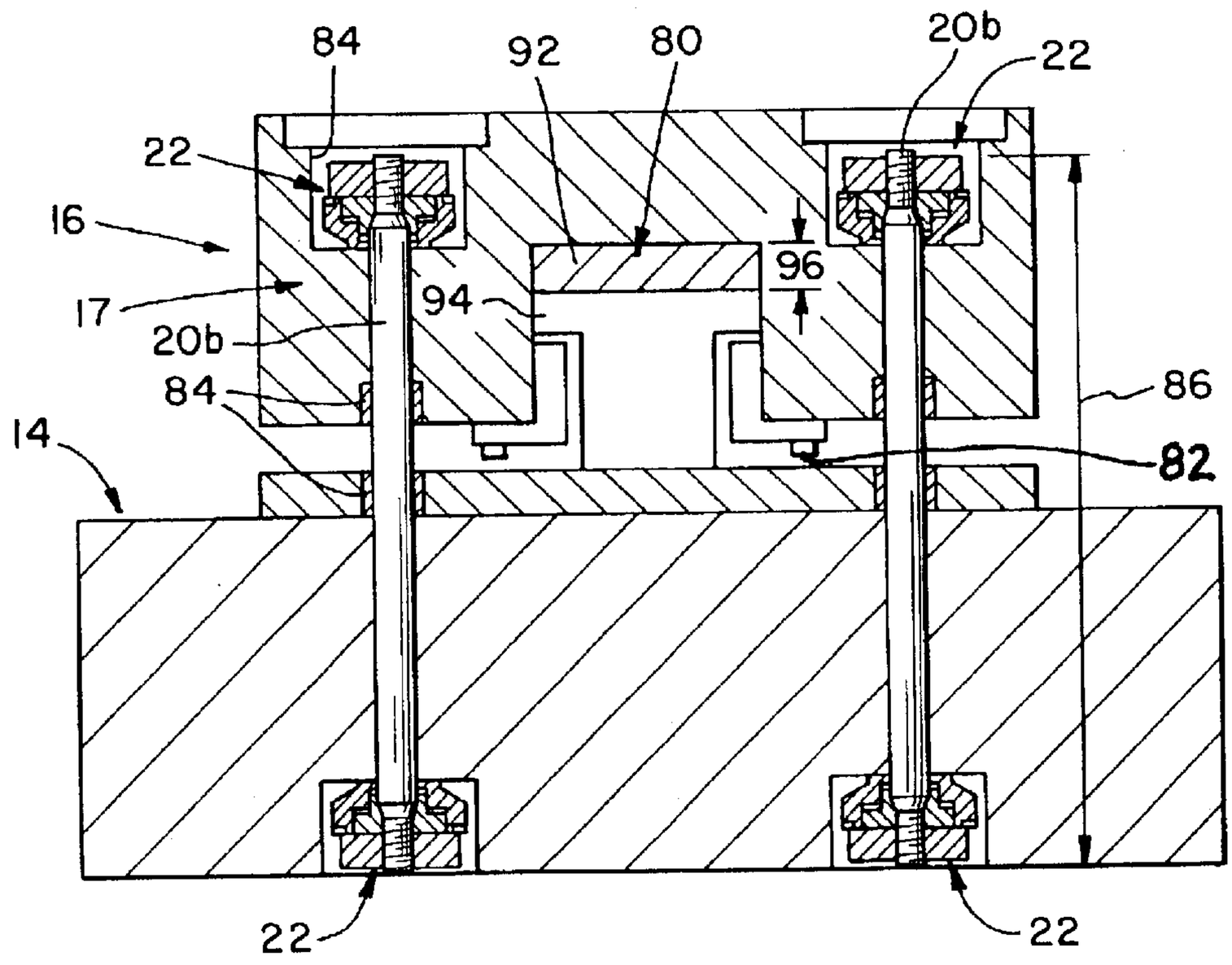
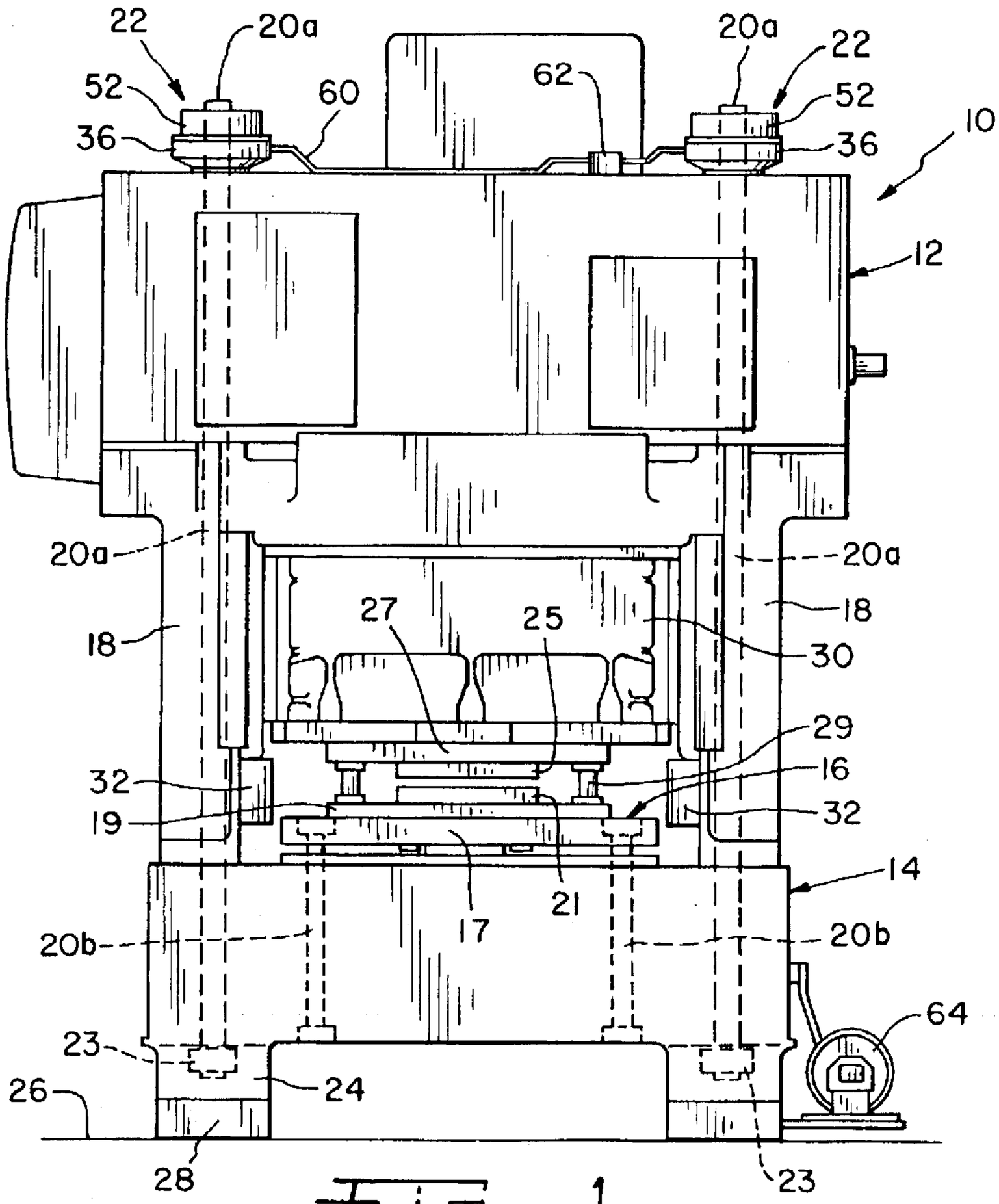
(57) **ABSTRACT**

A shutheight adjustment system incorporating tie rods and accompanying hydraulic tie rod nut assemblies in connecting a bed to a bolster of a mechanical press for dynamically altering the tensioning of the tie rods. Each hydraulic tie rod nut assembly includes a cylinder with an inner sliding piston threadably engaging the tie rod. A pressurizing mechanism injects pressurized fluid within a chamber formed by the piston and cylinder. By increasing pressure within the chamber of the hydraulic tie rod nut assembly, compression between the press bed and press bolster may be increased, thereby increasing the press shutheight.

20 Claims, 3 Drawing Sheets

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32
19
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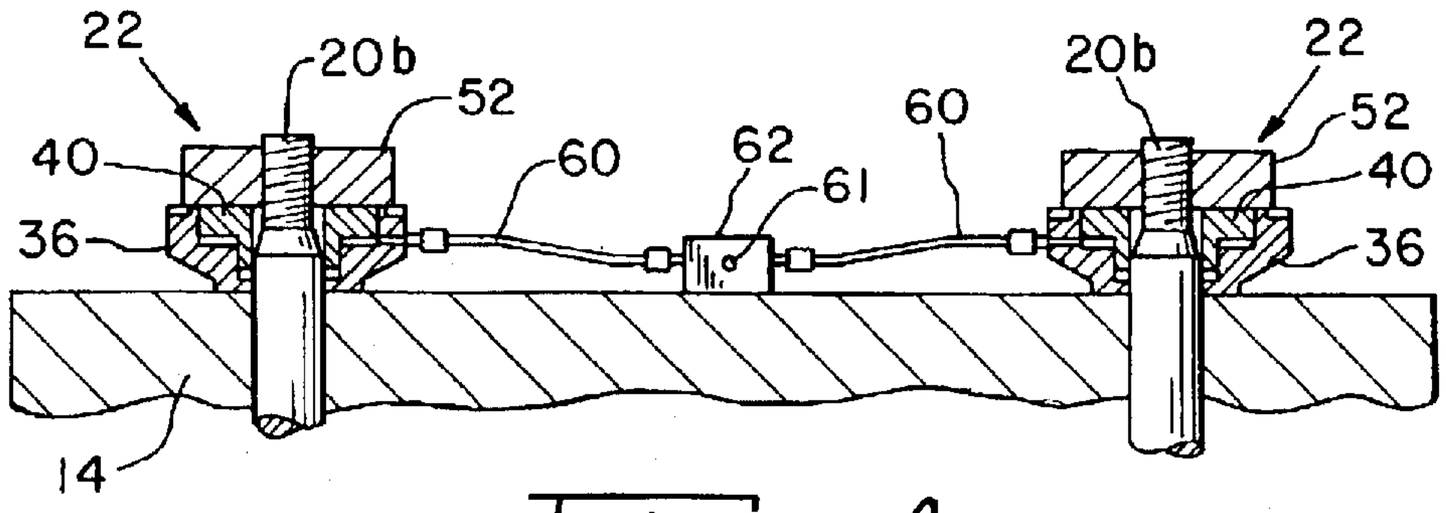
21
17
20b
20b
64
23
24
26
28
23

Fig. 1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20b
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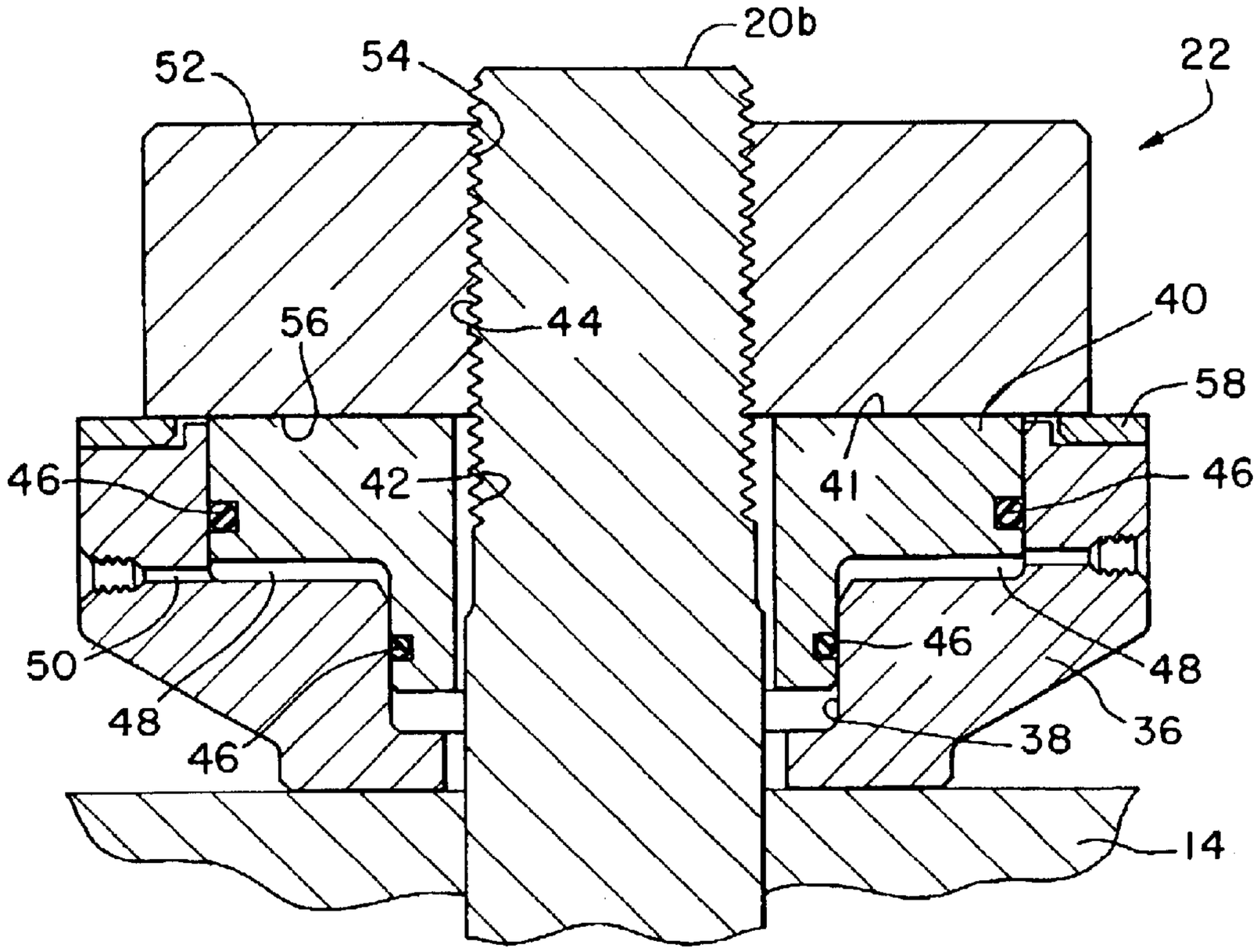
36
36
14

Fig. 4


20b
52
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22
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36
38
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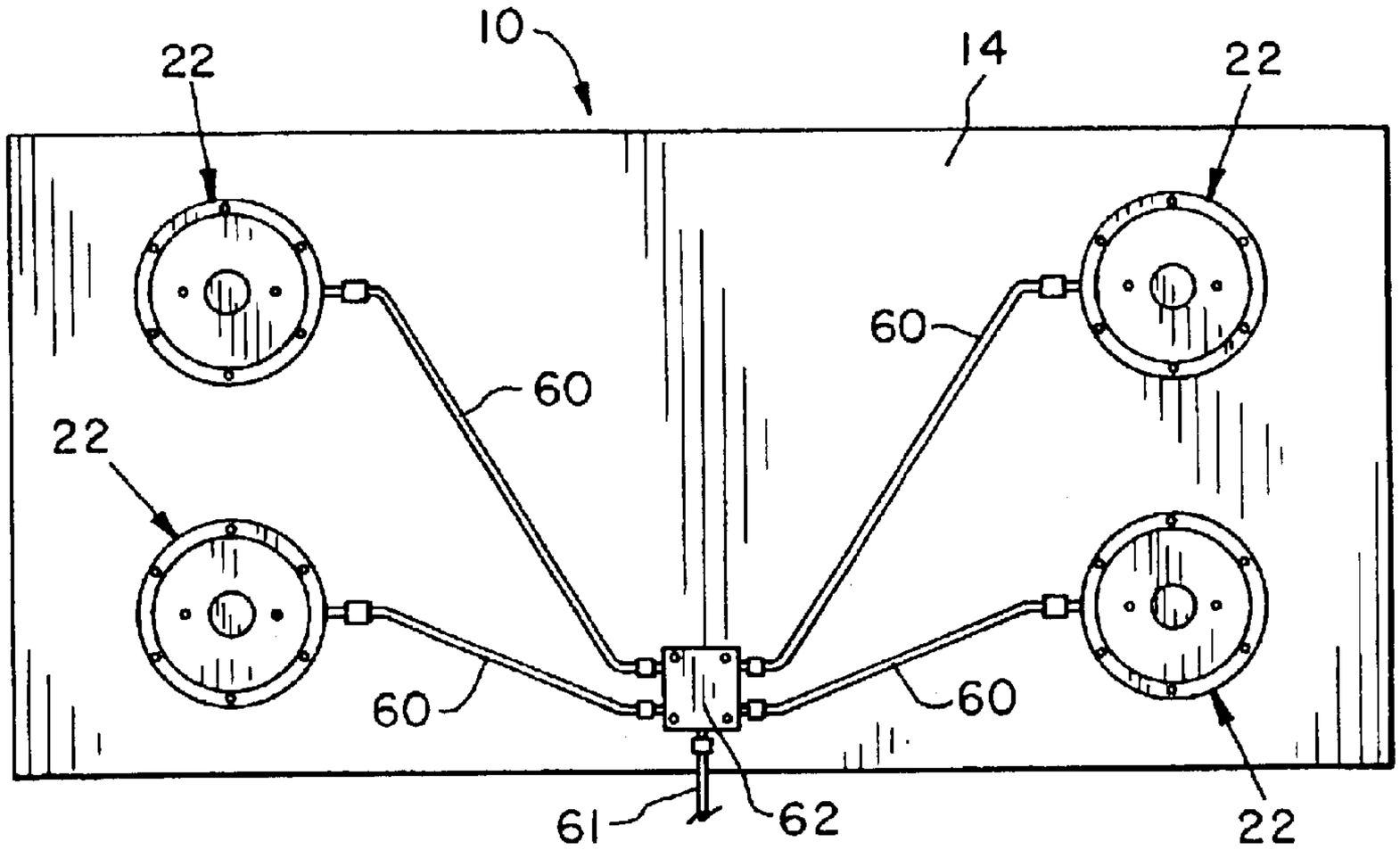
Fig. 2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22
14
22
60
60
22
60
60
61
62
22

Fig. 3

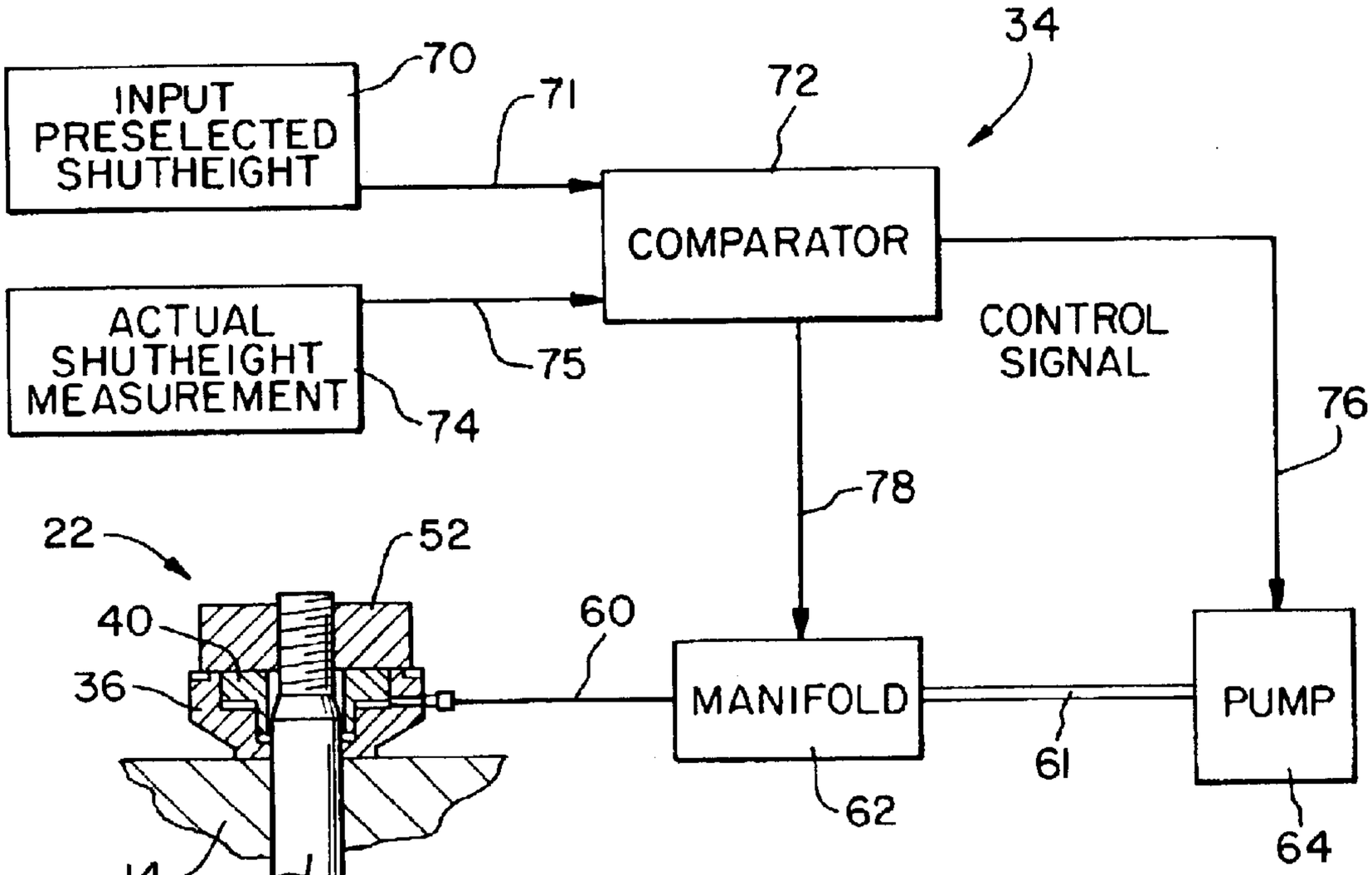
INPUT PRESELECTED SHUTHEIGHT
70
71
72
34
COMPARATOR
ACTUAL SHUTHEIGHT MEASUREMENT
74
75
CONTROL SIGNAL
76
78
22
52
40
36
60
MANIFOLD
PUMP
61
62
64
14
20b

Fig. 5

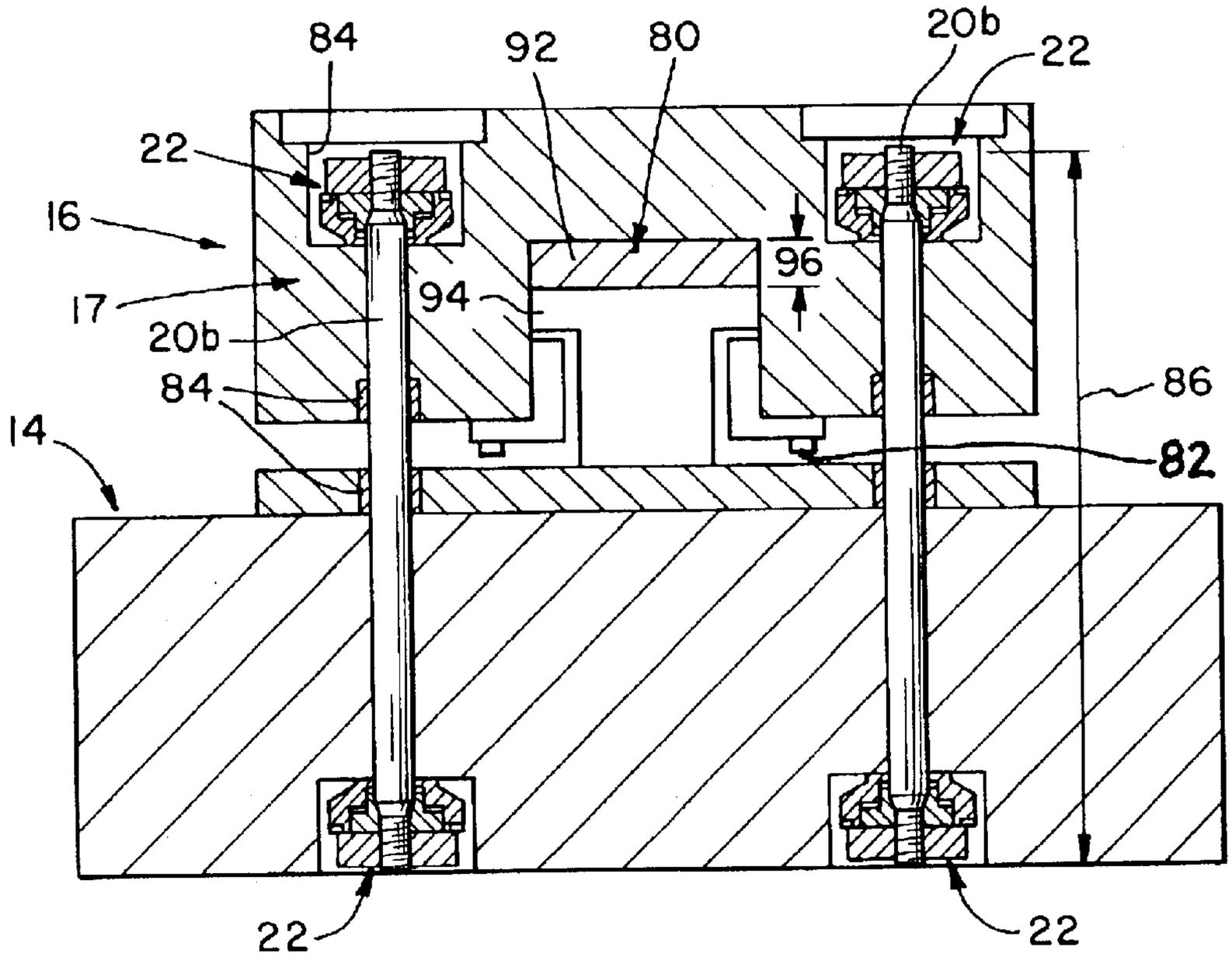
84
92
80
20b
22
16
17
94
96
86
82
14
22
22

Fig. 6

PRESS SHUTHEIGHT ADJUSTMENT USING BOLSTER HYDRAULIC TIE ROD ASSEMBLIES

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates generally to mechanical presses and, in particular, to a shutheight adjustment mechanism utilizing a bolster hydraulic tie rod assembly to change press shutheight while the press is operating.

2. Description of the Related Art

Mechanical presses, for example, stamping presses and drawing presses, include a frame having a crown and bed with a slide supported within the frame for motion toward and away from the bed. The slide is driven by a crankshaft having a connecting arm connected to the slide. Such mechanical presses are widely used for stamping and drawing operations and vary substantially in size and available tonnage depending upon the intended use.

In prior art presses of this type, the slide is generally connected to the crankshaft by a connection mechanism rod which is adjustable in length. The connecting rod is attached to another member that is adjustable in its relation to the slide so that the shutheight opening between the slide and the bed can be adjusted to accommodate various die sets. A normal slide adjustment mechanism adjusts the slide to a predetermined operating shutheight. Alternatively, the bed portion or bolster of the press may have its position adjusted relative to the slide so as to adjust the shutheight therebetween, as disclosed in U.S. Pat. No. 3,858,432. Regardless of the mode of shutheight adjustment, the slide is generally guided on the uprights of the press frame extending between the crown and the bed so that the parts of the die set remain in precise registration as the slide reciprocates.

A prior art patent, U.S. Pat. No. 4,502,379, shows a press in which shutheight is controlled by adjustment members located between the press crown and bed. Expansion and contraction of the adjustment members was accomplished by supplying hydraulic fluid into the members and thereby changing shutheight.

Another example of press shutheight control is described in U.S. Pat. No. 4,939,918, in which a fluid chamber beneath the lower press die is filled with pressurized oil to cause changes in press shutheight or load.

In mechanical presses utilized in stamping staked laminations, for example, there is a need to maintain shutheight tolerances to within 0.001 to 0.002 inches. Staked laminations are normally utilized in construction of the stator or rotor cores of electric motors. These laminations need precisely stamped surfaces to allow the laminations to be press fit together. Control of press shutheight is also necessary to maintain accurate part tolerances and prolong die life. A particular problem with punch presses is that the press shutheight normally varies with changes in press speed and thermal changes in the press itself.

The present invention is directed to fill the needs and overcome the aforementioned problems associated with mechanical press shutheight adjustment mechanisms wherein it is desired to accurately control shutheight while the press is in operation by controlling the connecting force on the press tie rods.

SUMMARY OF THE INVENTION

The present invention provides an adaptable feedback shutheight system capable of automatically changing the shutheight to compensate for various press conditions.

Generally the invention provides a bolster hydraulic tie rod nut assembly connected to a feedback system that automatically changes press shutheight to compensate for various press changes. The hydraulic tie rod nut is constructed to vary the connecting force between the bolster and the bed applied therebetween in response to changes in an applied hydraulic fluid. While monitoring the press shutheight, the feedback control system changes the pressure communicated to the expandable tie rod nut assemblies, thereby changing the amount of compression between the bed and bolster combination and ultimately press shutheight. Crown movement can be effected in a similar fashion (as set forth in U.S. Pat. 5,285,722 and incorporated by reference herein), permitting yet a further mode of controlling press shutheight.

An advantage of the hydraulic tie rod assembly is that by incorporating the tie rod nut assembly with the monitoring of the shutheight, a feedback system is created to automatically change the hydraulic pressure to the tie rod nut assemblies.

Another advantage of the present invention is that the tie rod nut assembly with its associated feedback system can maintain the press shutheight to within 0.001 inches to 0.002 inches under changing press operating conditions. Further, press shutheight is dynamically controlled while the press is cycling.

An additional advantage of the shutheight adjustment apparatus of the present invention is that the tie rod assembly may be installed easily without any major changes to the press slide drive system.

A further advantage of the shutheight hydraulic tie rod assembly system is that it is possible to retrofit existing presses with the new system for more accurate shutheight adjustment and control.

An even further advantage of the tie rod assembly, being mounted to couple the bed and bolster together, is that the hydraulic tie rod nut assembly, whether mounted adjacent the bed or the bolster, is in an accessible yet generally protected position within the machine press.

A further advantage associated with having a plurality hydraulic tie rod nut assemblies associated with the bolster and bed is that, due to their relative proximity to the press shutheight region, the plurality of hydraulic tie nut assemblies can be more readily used to adjust for variances in shutheight that may occur across the width of the press.

Yet another advantage of the present invention is that it is still possible to preload the press. Preloading the press structure eliminates clearances between press parts, thereby making the press more dimensionally stable.

The invention, in one form thereof, comprises a press in which a crown and bed are attached together by a frame. A slide is attached to the crown for reciprocating movement in opposed relationship to a bolster mounted upon the bed. A plurality of tie rods connect between the bolster and the bed onto which are attached a plurality of pressure-activated tie rod nut assemblies associated with the bed and bolster, so that when activated, the nut assemblies can be used to force the bolster and bed toward one another in order to increase shutheight. A feedback means is connected to a shutheight measuring means and to the tie rod nut assemblies for comparing a predetermined desired shutheight to a measured shutheight. The feedback means activates the tie rod nut assemblies when the measured shutheight deviates from the predetermined shutheight.

A pressure-activated tie rod nut assembly includes a cylinder block having a cylinder bore fit about a tie rod. A

piston is threadedly engaged about the tie rod and slidingly disposed within the cylinder bore thereby forming an inner chamber. A tie rod nut is threadably engaged about the tie rod, engaging the piston, so that when the inner chamber is pressurized with a fluid or liquid, the increase in pressure forces the piston and tie rod nut away from the cylinder block, thereby effectively forcing the bed and bolster together.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention will be better understood by reference to the following description of an embodiment of the invention taken in conjunction with the accompanying drawings, wherein:

FIG. **1** is a front elevational view of a mechanical press incorporating the shutheight adjustment mechanism of the present invention;

FIG. **2** is an enlarged sectional view of a single hydraulic tie rod assembly of the present invention;

FIG. **3** is a top plan view of the press of FIG. **1** showing four hydraulic tie rod assemblies;

FIG. **4** is an fragmentary enlarged front elevational view of the bed of the mechanical press of FIG. **1**;

FIG. **5** is a schematic of the feedback means of the present invention; and

FIG. **6** is a schematic, cross-sectional view of the bed and bolster combination of the present invention.

Corresponding reference characters indicate corresponding parts throughout the several views. The exemplification set out herein illustrates one preferred embodiment of the invention, in one form, and such exemplification is not to be construed as limiting the scope of the invention in any manner.

DETAILED DESCRIPTION OF THE INVENTION

Referring now to FIG. **1**, mechanical press **10** comprises a crown portion **12**, a bed portion **14** having a bolster assembly **16** connected thereto and uprights **18** connecting crown portion **12** with bed portion **14**. Bolster assembly comprises a bolster **17** having an attached lower die shoe **19** including a die **21**. An opposed die **25** is attached to an upper die shoe **27** connecting with slide **30**. A plurality of guide posts **29** are disposed between the upper and lower die shoes **25**, and **19** in a known fashion.

Uprights **18** are connected to or integral with the underside of crown **12** and the upper side of bed **14**. The slide **30** is attached to crown **12** for reciprocating movement in opposed relation to bed **14**.

Although press **10** is shown in a press down configuration, it could alternatively be constructed in a press up configuration by constructing the press upside down. In a press up configuration, slide **30** would be connected to the lower unit instead of the top unit, in this case, crown **12**. If slide **30** was connected to the lower unit, the lower unit could be referred to as the crown.

Leg members **24** are formed as an extension of bed **14** and are generally mounted on the shop floor **26** by means of shock absorbing pads **28**. Tie rods **20***a* extend through crown **12**, uprights **18** and bed portion **14**, and tie rods **20***b* extend through bed **14** and bolster **16**. Additionally, tie rods **20***a, b* are attached on one end with tie rod nut assemblies **22** of the present invention. On the other end of tie rods **20***a, b* are standard, non-expandable tie rod nuts **23**. Optionally, although not shown, both ends of tie rods **20***a, b* could each be provided with a tie rod nut assembly **22** to facilitate greater shutheight control.

Press shutheight is controlled by first measuring the shutheight between slide **30** and bolster **16** by a shutheight measuring means **32** such as a limit switch, an accelerometer or a non-contacting optical or electrical sensing means as is known in the art. A preferred non-connecting sensor is an eddy current transducer.

Measurement of shutheight may also be achieved by measuring the pressure loads or vibrations through the press. Alternate methods of measuring shutheight may include monitoring press speed or the quality of workpieces produced by the press. The present invention is directed to improve and supplement current shutheight adjustment mechanisms thereby permitting shutheight adjustment while press **10** is cycling (i.e., adjustment in motion).

In the present invention, each hydraulic tie rod nut assembly **22** is connected to a feedback system **34** which receives shutheight input from shutheight measuring means **32** (FIG. **5**). Each hydraulic tie rod nut assembly **22** includes an annular cylinder **36** mounted upon one of crown **12**, bolster **16**, and bed **14**, as appropriate, and about one of tie rods **20***a, b* (See FIG. **2**). Cylinder **36** includes an annular bore **38** about tie rod **20***a, b* into which an annular piston **40** is slidingly interfit. Piston **40** includes an annular threaded bore **42** which is threadably engaged on threads **44** of tie rod **20***a, b*. Piston **40** sealingly interfits within bore **38** by means of seals **46**. Seals **46** seal between piston **40** and cylinder **36** defining a chamber **48**. As shown in FIG. **2**, chamber **48** is connected to an oil inlet **50** that is constructed through cylinder **36**. Oil inlet **50** is in communication with an oil line **60** in fluid communication with oil purged by a pump **64** (FIG. **5**). The present construction permits piston **40** to slide within cylinder **36** based on the pressure of oil injected through cylinder **50**.

On piston **40** and about tie rod **20***a, b* is threaded a tie rod nut **52** (as shown on tie rod **20***b* in FIG. **2**). Nut **52** includes an annular bore having threads **54** that engage threads **44** of tie rod **20***a, b*. The bottom surface **56** of tie rod nut **52** engages a top surface **41** of piston **40**. A metallic preload spacer element **58** is interfit between cylinder **36** and tie rod nut **52** to maintain a selected preload. Spacer **58** is ground or formed so as to be flat and interfit between cylinder **36** and nut **52** with barely any clearance. Spacer **58** will maintain the initial preload of the press in the event that oil pressure within chamber **48** is relieved. Spacer **58** thickness can be calculated on the basis of the theoretical or measured stretching of the tie rod, compression of the crown, uprights and bed of press **10** during operation.

The feedback means for automatically controlling the shutheight will be discussed in relation to FIG. **5**. However, it is understood and appreciated that alternative control arrangements may be utilized to control the shutheight and the required hydraulic pressure.

Automatic control of shutheight is maintained by a control feedback means **35** as shown in FIG. **5**. Prior to operation, the press operator inputs a preselected shutheight through line **71** into a comparator **72**. Feedback means **34** along with comparator **72** may comprise a microprocessor. Alternatively, comparator **72** may be constructed from a programmable logic controller as is known in the art. Comparator **72** receives input signals and provides output or control signals as a function of its inputs.

Shutheight measuring means **32** of FIG. **1** transmits an actual shutheight measurement **74** through line **75** to comparator **72** during press operation. Comparator **72** compares the difference between the preselected shutheight **70** and the actual shutheight **74** and forms a control signal on line **76** to an oil pressurizing means such as oil pump **64**. Pump **64** may be a typical air-over-oil pump to variably control the oil pressure within tie rod nut assemblies **22**. Pump **64** connects to manifold **62**, thereby pumping oil into and controlling pressurized oil therein. Manifold **62** communicates the pressurized oil by oil lines **60** to various hydraulic tie rod nut assemblies **22**. The result of the comparison between the preselected shutheight **70** and the actual shutheight measurement **74** causes comparator **72** to vary the control signal on line **76** to pump **64** to vary oil pressure to the hydraulic tie rod nut assembly **22**, thereby changing the compression between press bed **14** and press crown **12**. Shutheight **25** is controlled by changing the oil pressure within chamber **48**.

Alternatively, comparator **72**, based on its inputs, may vary and send a control signal on a line **78** to manifold **62** to vary the applied pressure of oil to any particular tie rod nut assembly **22**. In this fashion, oil pressure within clearance space **48** may be controlled by a valve selectively opening and closing, such as an electric solenoid valve or throttle as is known in the art. The alternate valve may be integral to manifold **62**. If necessary, comparator **72** may control more than one pump **64** and manifold **62**.

If comparator **72** determines that the actual press shutheight **74** is too small, a control signal is sent through line **76** to cause pump **64** to increase pressure within chamber **48**, thereby increasing shutheight by compressing press bolster closer to press bed **14**. When the measured shutheight **74** is too large, comparator **72** will signal pump **64** to reduce pressure within chamber **48**.

At initial assembly, the press **10** will be preloaded at approximately full press tonnage. During this preload, oil is injected through oil inlet **50** into chamber **48**. This oil is then pressurized to approximately 1200 PSI for a typical 100 ton press to approximate the full press tonnage. During the preload process, the pressure within chamber **48** will cause piston **40** to slide within bore **38** away from crown **12**. As piston **40** slides away from crown **12** forcefully engaging and pressing into tie rod nut **52**, a larger space will develop between cylinder **36** and tie rod nut **52**. At the full preload pressure, the spacer element **58** of the preload separation between tie rod nut **52** and cylinder **36** is interfit therebetween. The insertion of spacers **58** are used to maintain the gap and preload stress between nut **52** and cylinder **36**.

The tie rod nut assembly **22** is preferably attached to each of the tie rods in press **10**. As shown in FIG. **3**, four tie rod assemblies **22** are attached to the four tie rods **20***b* of press **10**. FIG. **3** shows each tie rod nut assembly **22** connected by a high pressure oil hose **60** to a manifold **62**. However, it is envisaged that placing tie rod nut assemblies **22** on two or three of tie rods **20***b* may prove sufficient under certain circumstances.

The details of the combination of bed **14** and bolster **17** are best illustrated in FIG. **6**. In addition to bed **14** and bolster **17** (of bolster assembly **16**), the combination includes a plurality of tie rods **20***b*, a plurality of tie rod nut assemblies **22**, a quick access adjustment mechanism **80**, at least one limit stop **82**, and guide bushings **84**.

To reduce press shutheight, the operator would use the hydraulic system to increase pressure to adjustment mechanism **80** and decrease or eliminate pressure to the hydraulic tie rod nuts **22**. The comparator/monitoring system for automatic shutheight control could use a combination of inputs including pressure at adjustment mechanism **80** and chamber **48**.

Each bed **14** and bolster **17** is provided with a plurality of rod receiving channels **88** for receiving corresponding tie rods **20***b*. Additionally, bed **14** and bolster **17** further have a plurality of nut receiving cavities **90** formed therein, each receiving cavity **90** being associated with one of rod receiving channels **88**. Each nut receiving cavity **90** faces away from the area between bed **14** and bolster **17**.

Each tie rod **20***b* has an associated tie rod length **86**. Pressure-activated tie nut assemblies **22** permit fine tune adjustment of tie rod length **86** (to about 0.010 inches). This fine tune adjustment of the length involves corresponding adjustment of shutheight **74** (i.e., an increase in rod length/tension results in an increase in compression between the bed and bolster, thereby producing a shutheight decrease). In this environment, both the bed and the bolster end of each of tie rods **20***b* is provided with a tie rod nut assembly **22**, thereby facilitating a adjustment of the overall length of each tie rod **20***b* from either end thereof. However, it is also contemplated, although not shown that one of the bed set and bolster set of tie rod nut assemblies could be replaced with a set of standard nuts.

Quick access adjustment mechanism **80** is operatively positioned between bed **14** and bolster **17**. Quick access adjustment mechanism **80** is hydraulically controlled, being configured for receipt of an adjustable amount of a hydraulic fluid **92** and being supplied with a quick access piston **94** for acting upon hydraulic fluid **92**. The height adjustment achieved with quick access adjust mechanism **80** is referred to herein as quick access height adjustment amount **96**, as indicated in FIG. **6**. Quick access height adjustment amount **86** can be on the order of inches, thereby allowing relatively easy access to the area between bed **14** and bolster **17**. Conversely, quick access height adjustment amount **96** can be reduced to a new order of the required shutheight amount during press operations.

At least one limit stop **82** is provided to act as a limit for the degree of stretching possible within tie rods **20***b* and to act as a limit on the maximum quick access height adjustment amount **96**.

Guide bushings **84** are provided in each rod receiving channel **88** adjacent the interface region between bed **14** and bolster **17**. Guide bushings **84** help minimize the vibration of tie rods **20***b*.

The operation of tie rod nut assemblies **22** associated with the bed and bolster combination, in a manner similar to operation of tie rods **20***a* associated with crown **12**, uprights **18**, and bed portion **14**, is controlled via shutheight measuring means **32** in feedback system **34**. Further, each hydraulic tie rod nut assembly **22** associated with the bed and bolster combination is advantageously constructed and configured in a manner similar to those described for use with respect to crown **12**, upright **18**, and bed **14**.

In operation, press shutheight is controlled by first measuring the shutheight between slide **30** and bolster die **16** by a shutheight measuring means **32** such as a limit switch or a non-contacting sensing means such as an eddy current transducer or a laser/photo sensor. The use of multiple shutheight measuring means **32** permits detection of possible variances in shutheight across the press zone.

The present invention improves current shutheight adjustment mechanisms by permitting shutheight adjustment while press **10** is cycling (i.e., adjustment in motion). By comparing the measured shutheight value to a predeter-

mined desired shutheight value, a decision is made whether to increase or decrease the shutheight of the press. Known means for creating this feedback system include programmable logic controllers and standard electronic computers that may be programmed to compare the two shutheight values and provide a signal to actuate a valve or pump (such as air over oil pump **64**).

Upon the condition sensed by feedback means **34** that shutheight should be increased, oil pressure within manifold **62** and therefore tie rod nut assemblies **22** is increased. From an approximate preload pressure of 1200 PSI for a typical 100 ton press, the feedback means **34** may vary the pressure from 1200 to 3500 PSI. This range of pressure changes should result in differences of approximately 0.010 inches in shutheight. Conversely, the shutheight can be decreased up to a maximum corresponding to the return of a tie rod to its original prestressed state, achieved by releasing the oil pressure within manifold **62**.

As shown in FIG. **1**, a shutheight measuring means **32** is incorporated near slide **30**. A pressurizing means, such as a pump **64** for pumping pressurized oil, is connected by means of an oil line **61** to manifold **62**. Manifold **62** is connected by oil pressure lines **60** to the hydraulic tie rod nut assemblies **22**. The feedback means **34** may be directly incorporated on the motor controller **4**, motor **64** or on a separate unit.

The shutheight adjustment mechanism described may be installed easily to a press **10** without any changes in the press slide drive. Also, hydraulic tie rod nut assemblies **22** may be retrofitted to existing mechanical presses. By using a non-contacting shutheight measuring means, virtually no structural changes are needed to the press running gear. The feedback system described automatically changes the hydraulic pressure within hydraulic tie rod nuts **22** to vary the shutheight.

While this invention has been described as having a preferred design, the present invention can be further modified within the spirit and scope of this disclosure. This application is therefore intended to cover any variations, uses, or adaptations of the invention using its general principles. Further, this application is intended to cover such departures from the present disclosure as come within known or customary practice in the art to which this invention pertains and which fall within the limits of the appended claims.

What is claimed is:

1. A press comprising:

a crown and a bed attached together by a frame, said bed having a bolster attached thereto;

a slide attached to said crown for reciprocating movement in opposed relation to said bed;

a plurality of tie rods connecting between said bolster and said bed;

a plurality of pressure-activated tie rod nut assemblies attached to at least two said tie rods adjacent one of said bolster and said bed so that when activated, said tie rod nut assemblies force said bolster toward said bed;

a shutheight measuring means for measuring the shutheight of said press, said shutheight measuring means associated with said press; and

feedback means connected to said shutheight measuring means and said tie rod nut assemblies for comparing a predetermined desired shutheight to the shutheight measured by said measuring means and pressure activating said tie rod nut assemblies when the measured shutheight deviates from the predetermined shutheight, whereby shutheight is controlled.

2. The press of claim **1** in which a tie rod nut assembly comprises:

a cylinder block having a cylinder bore fit about said tie rod;

a piston threadedly engaged about said tie rod and slidably disposed within said cylinder bore, thereby forming an inner chamber, said inner chamber pressurized with a liquid; and

a tie rod nut threadably engaged about said tie rod and engaging said piston.

3. The press of claim **2** in which said inner chamber is further defined by seals between said piston and said cylinder block.

4. The press of claim **2** in which said liquid comprises oil.

5. The press of claim **2** in which said tie rod nut assembly includes a spacer interfit between said nut and said cylinder block to maintain a desired preload on said bolster without said tie rod nut assemblies being pressurized.

6. The press of claim **2** having at least two said tie rod nuts assemblies in which said inner chambers of said tie rod nut assemblies are connected together by a manifold.

7. The press of claim **2** in which said feedback means controls the shutheight of the press by altering the pressure within said inner chamber.

8. The press of claim **1** in which said feedback means comprises:

a pump connected to said tie rod nut assemblies and activated by a control signal for changing the pressure of liquid communicated to said tie rod assemblies; and

comparator means having input lines for a measured shutheight from said shutheight measuring means and a predetermined desired shutheight, said comparator means including a signal output line connected to said pump, said comparator means causing a control signal to be formed on said output line on the basis of a comparison between a measured shutheight and a predetermined desired shutheight.

9. A press comprising:

a crown and a bed attached together by a frame, said bed having a bolster attached thereto;

a slide attached to said crown for reciprocating movement in opposed relation to said bed;

a plurality of tie rods connecting between said bolster and said bed;

a plurality of pressure-activated tie rod nut assemblies, at least two said tie rods having at least one tie rod nut assembly mounted thereto adjacent one of said bolster and said bed, each said tie rod nut assembly including a cylinder block having a cylinder bore fit about said tie rod, a piston threadedly engaged about said tie rod and slidably disposed within said cylinder bore, thereby forming an inner chamber, said inner chamber pressurized with a liquid, and a tie rod nut threadably engaged about said tie rod and engaging said piston so that an increase in pressure within said inner chamber forces said tie rod nut away from said cylinder block;

a shutheight measuring means for measuring the shutheight of said press, said measuring means operatively associated with said press; and

feedback means connected to said shutheight measuring means and to said tie rod nut assemblies for comparing a predetermined desired shutheight to the shutheight measured by said measuring means and altering the

pressure within each said inner chamber when the measured shutheight deviates from the predetermined shutheight, whereby shutheight is controlled.

10. The press of claim **9** in which said feedback means includes a pump to pressurize said liquid, said pump controlled by said feedback means.

11. The press of claim **9** in which said feedback means includes a manifold connected to said inner chambers of said tie rod nut assemblies.

12. The press of claim **9** in which said feedback means controls the pressure within each tie rod nut assembly individually.

13. The press of claim **9** in which said liquid is pressurized to between 1200 p.s.i. and 3500 p.s.i.

14. The press of claim **9** in which said tie rod nut assembly includes a spacer interfit between said tie rod nut and said cylinder block to maintain a desired preload on said bolster without said tie rod nut assemblies being pressurized.

15. The press of claim **9** in which said inner chambers of said plurality of said tie rod nut assemblies are connected together by a manifold.

16. The press of claim **9** in which said feedback means comprises:

a pump connected to said inner chambers of said plurality of tie rod nut assemblies and activated by a control signal for changing the pressure of said liquid communicated to said inner chambers of said plurality of said tie rod assemblies; and

comparator means having input lines for a measured shutheight from said shutheight measuring means and a predetermined desired shutheight, said comparator means including a signal output line connected to said pump, said comparator means causing a control signal to be formed on said output line on the basis of a comparison between a measured shutheight and a predetermined desired shutheight.

17. A press comprising:

a crown and a bed attached together by a frame;

a bolster attached to said bed at a position intermediate said bed and said crown;

a slide attached to said crown for reciprocating movement in opposed relation to said bolster, said slide and said bolster having a shutheight associated therewith;

a plurality of tie rods connecting said bolster to said bed; and

a plurality of pressure-activated tie rod nut assemblies, at least two said tie rods having at least one tie rod assembly mounted thereto adjacent one of said bolster and said bed, each said tie rod nut assembly being configured for selectively adjusting at least one of tolerance and compression between said bed and said bolster to thereby effect a proportional change in the shutheight.

18. The press of claim **17**, further comprising a quick access adjustment mechanism for adjusting a relative bolster height of said bolster, said quick access adjustment mechanism being operatively positioned between said bed and said bolster, said quick access adjustment mechanism being hydraulically activated.

19. The press of claim **18**, further comprising at least one limit stop associated with one of said bed and said bolster, each said limit stop limiting a degree of relative bolster height adjustment that can be made using said quick access adjustment mechanism.

20. The press of claim **18**, wherein said quick access adjustment mechanism and said plurality of tie rod nut assemblies are capable of being used conjunctively to effect the shutheight.

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